Understanding the Energy Intensity of Water Systems

Meredith Leigh Younghein, JD
Water/Energy Analyst
CPUC-Energy Division
State Water Resources Control Board

Big Picture Questions:

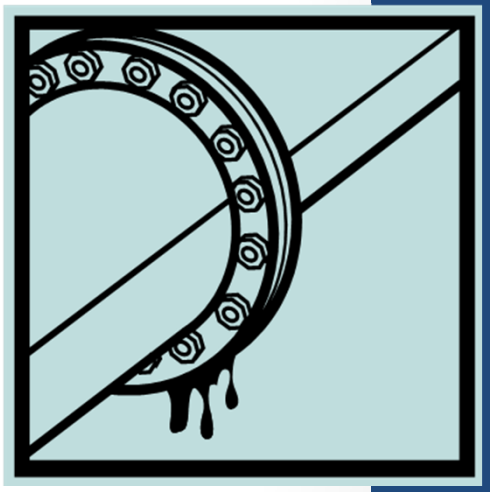
- When water efficiency programs save energy and reduce GHGs, how do we account for these savings?
  - What is the value to energy and water ratepayers?
  - What is the value to California?

The Current Demand-Side Portfolio aims to reduce Energy used for Water

- Energy Efficiency programs:
  - “Industrial” Custom projects for water agencies/utilities/districts
  - Local Government and Institutional Partnerships
  - Agricultural: pumping & irrigation efficiency
- Integrated Demand Side Management
  - Encouraging DR and DG simultaneously with EE improvements
- Continuous Energy Improvement
  - create and implement strategic energy management plans at water agencies, using a “cohort” model

Past CPUC Efforts on Water-Energy

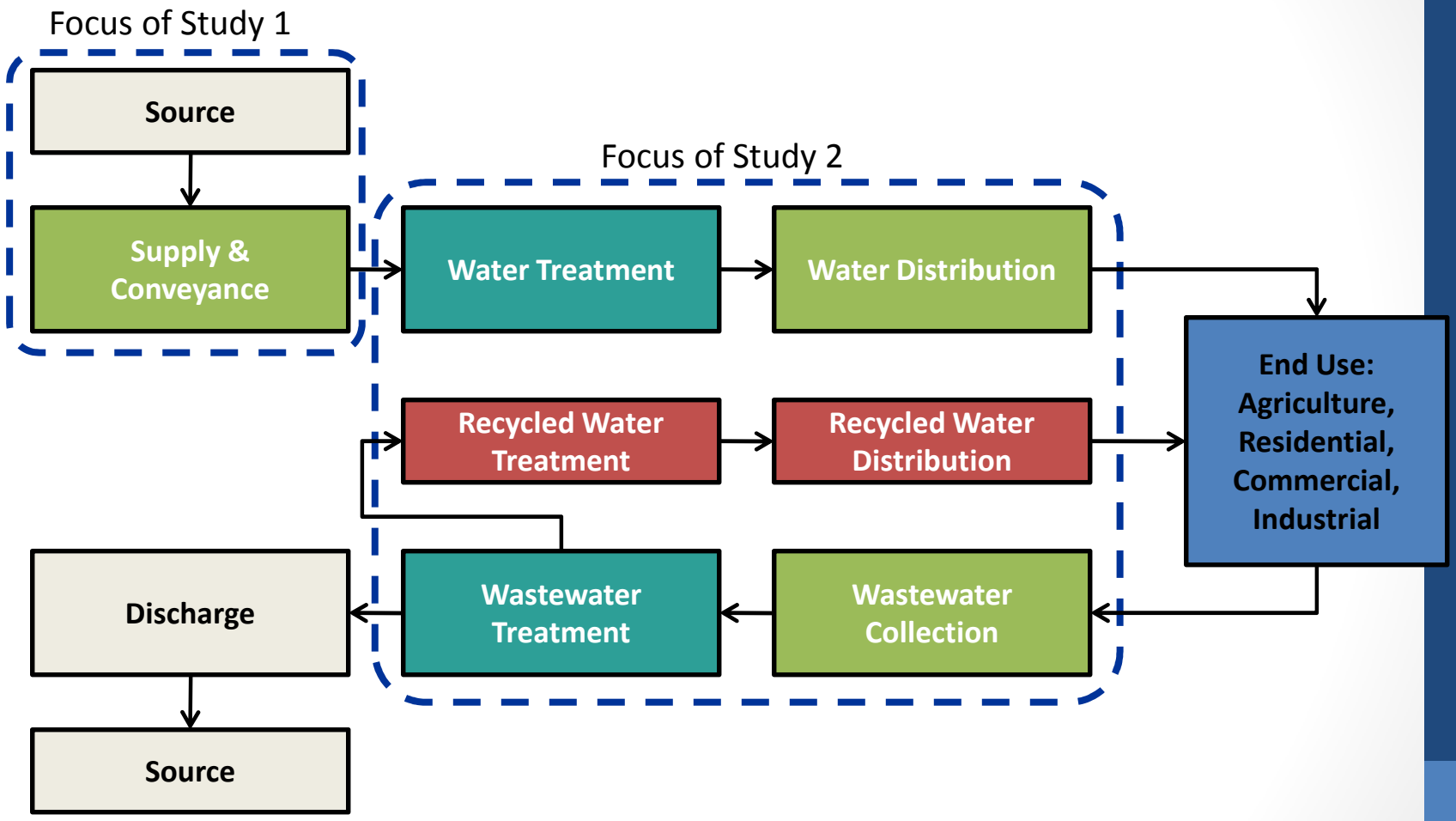
- Three comprehensive studies on “Water Energy Relationship” (2009-2012)
- Water-Energy Pilot Projects (2007-2011)
  - Leak/loss detection and pressure management
  - Landscape irrigation efficiency
  - High efficiency toilets
  - Ozone laundry
  - More
- All materials can be downloaded via: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Water-Energy+Nexus+Programs.htm



CPUC Embedded Energy In Water Studies » Background

- In 2007, the CPUC opened a proceeding to consider if/how energy embedded in water should be recognized as an energy efficiency resource.
- Decision 12-07-050: Directed that three studies be conducted:
  - Study 1 - Statewide and Regional Water Energy Relationship Study
  - Study 2 - Water Agency and Function Component Study and Embedded Energy - Water Load Profiles
  - Study 3 - End-Use Water Demand Profile Study
- The CPUC engaged the California Institute for Energy and Environment (CIEE) to manage the three studies. The team of GEI Consultants, Inc. and Navigant Consulting, Inc. (the Study Team) was engaged to conduct Study 1 and Study 2.
- Both studies collected and analyzed significant amounts of water and energy data:
  - 10 years worth of water and energy data for nine large wholesale suppliers
  - One year of detailed monthly/hourly data for 20+ retail water agencies throughout California
  - Secondary analysis of additional water supplies (groundwater, recycled water, desalination, local surface water)

The two studies looked at different parts of the water system



Energy Intensity and Embedded Energy are two terms that are key to understanding the Water-Energy nexus

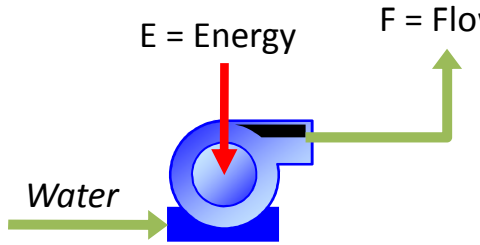
» **Energy Intensity (EI)**

- The average amount of energy needed to transport or treat water or wastewater on a per unit basis (kilowatt hours per acre-foot of water [kWh/AF]).
- The energy intensity is associated with a particular facility and is similar to a measure of efficiency.
- The energy intensities of individual facilities within a water agency can be aggregated to represent the energy intensity of water supply.

» **Energy Embedded in Water**

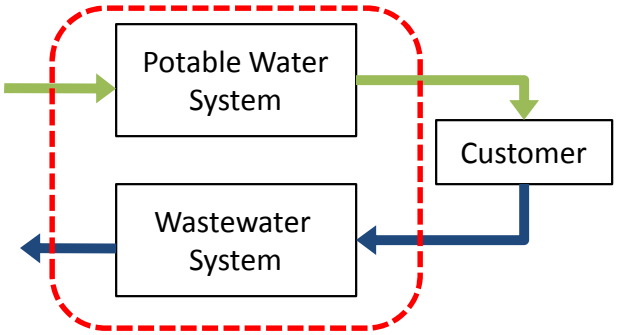
- The amount of energy that is used to provide water to end users and the amount of energy that is used to collect and transport wastewater for treatment prior to safe discharge of the effluent.
- Captures the entire energy picture both upstream and downstream of an end use customer.
- Useful in quantifying energy savings as a result of water savings (water saved x EI = embedded energy saved)

Illustrative Energy Intensity Calculation for a Pump



$$EI = \frac{E}{F}$$

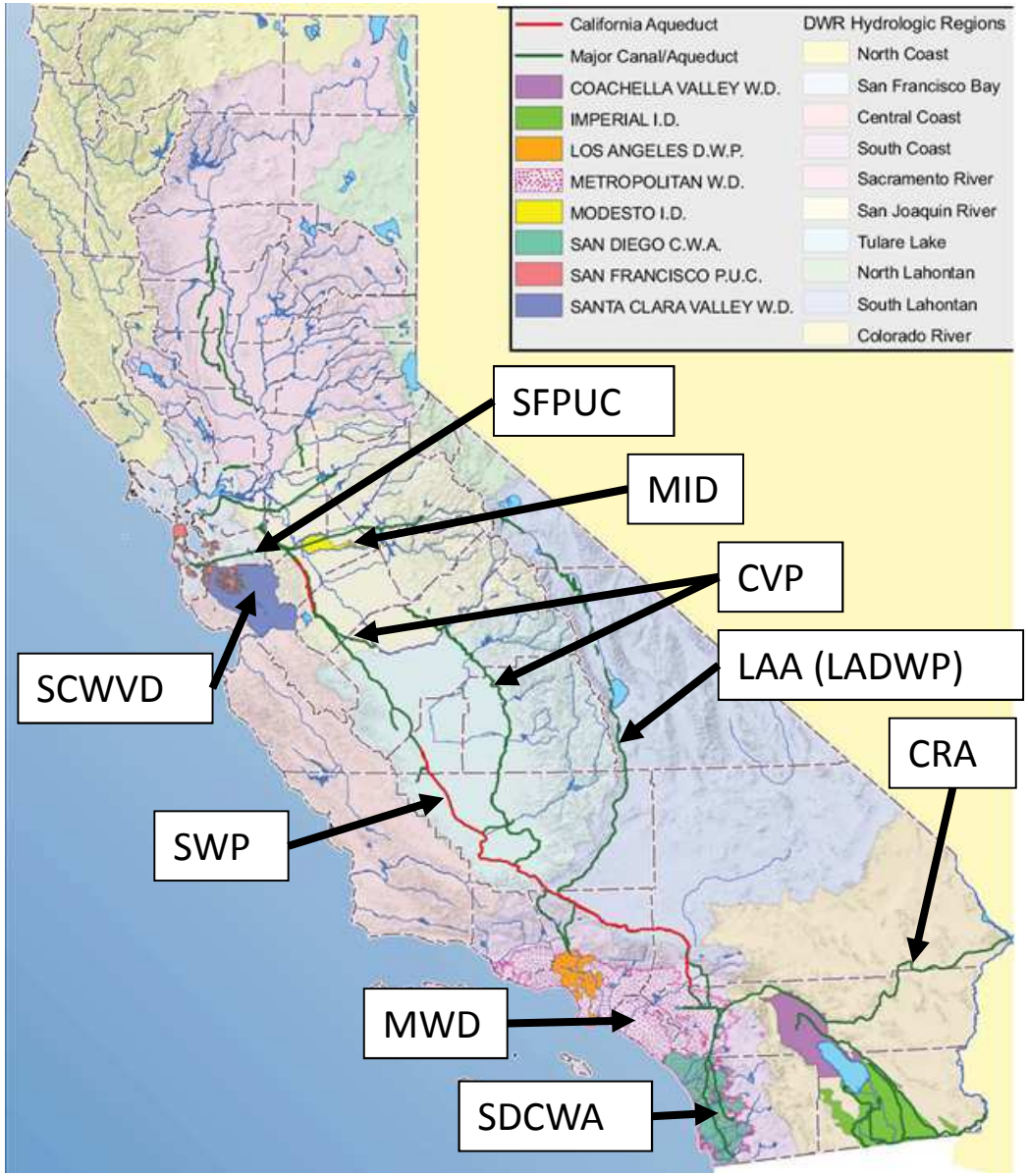
Embedded Energy



Energy Use = Embedded Energy

Study 1 aimed to understand and quantify the primary predictors of energy consumption related to water supply systems

- The Study Team collected 10 years of water and energy data from 9 wholesale agencies to develop a predictive model of energy use.
  - Most of these large pumping plants are powered by non-IOU energy
- Also characterized energy use for water supply types NOT supplied by those 9 agencies
  - Groundwater
  - Local Surface Water
  - Recycled Water
  - Desalination (Brackish and Seawater)
- **Take away: these "other" supplies include more IOU embedded energy!**



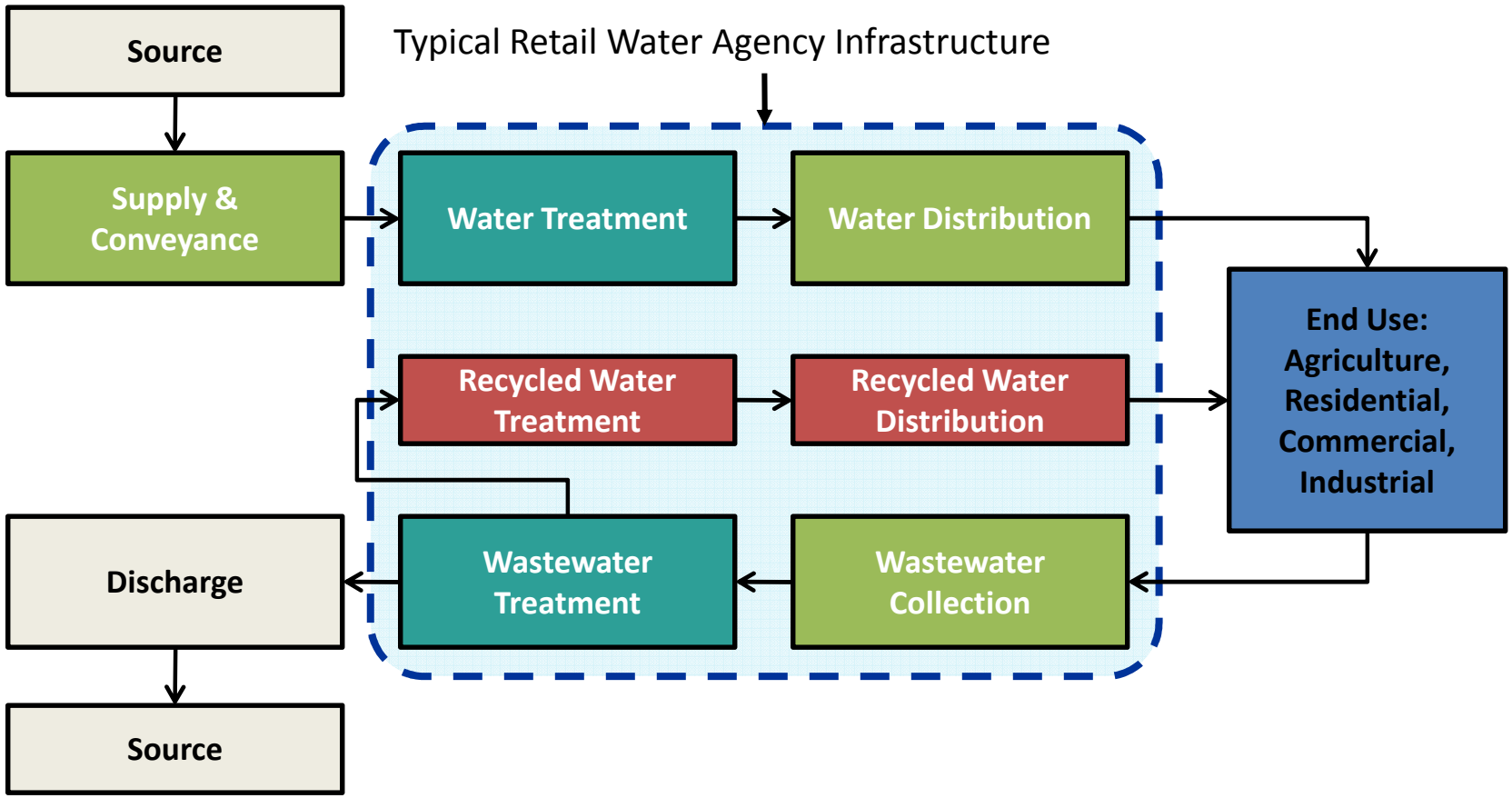
Study 1 take away:

- We understand much better now what information we need about the energy embedded in water supplies than we did at the outset of study 1
- If we knew then what we knew now, the study may have had a different focus
- Main outcome is the EI of various water supply types in different regions: but this information is *buried* in the Study 1 report
- Now, DWR is doing its own EI study of the State Water Project, and including it in the Water Plan—this has never been done before (CPUC and CEC studies were first to estimate)

Study 2: the team developed and refined methodologies for calculating energy intensity and embedded energy.

Indentify Infrastructure	Collect Energy and Water Data	Interview System Operators	Develop Analysis Algorithms	Analyze Results
» Identify various sources of water for a given agency » Understand the types of infrascture (pumps, reservoirs, canals) » Understand inter-connections	» Collect water delivery data and pump energy use data. » Link water and energy data for each piece of infrastructure	» Understand operational strategy, identify marginal supply » Address data inconsistencies	» Develop methodology to calculate system wide energy intensity » Account for multiple supplies, sources, and delivery points.	» Implement methodology in a calculation tool to process data » Examine trends and ranges of energy intensity » Produce example energy load profiles

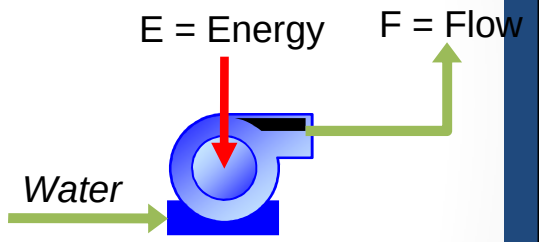
Retail water agencies use energy in multiple end uses: groundwater pumping, treatment, distribution, wastewater treatment, and more.



Study 2 take aways: Varying levels of data are available for retail water utilities; lack of granularity does not prevent calculation of energy intensity.

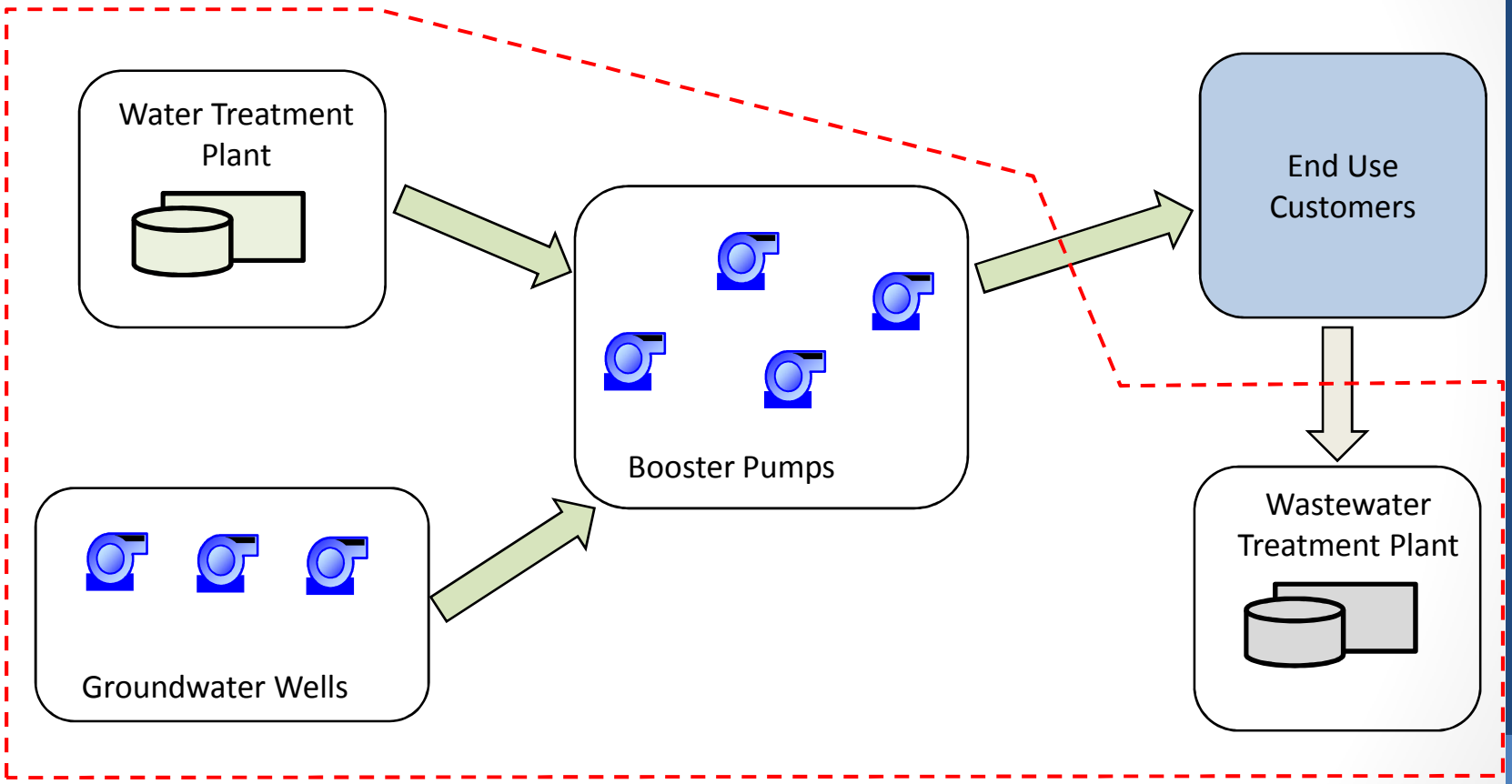
- Energy data is often available for each facility within a water agency (sometime upwards of 100 facilities)
  - Monthly energy bill data (sometimes time of use data is available)
- Water data is often only available at key points in the system (sometimes only 5-10 locations): effluent from treatment plants, production by groundwater wells
  - While water utilities may have SCADA to monitor flow rates and pressure live, historic data is not always recorded
  - Monthly water production data is regularly recorded
  - Rarely are water flow data for individual distribution pumps available
- Study 2 saw many cases where detailed energy data was available, but water data was available only at a monthly level at a few key points
- **However, this does not prevent calculation of EI…**

Illustrative Energy Intensity Calculation for a Pump



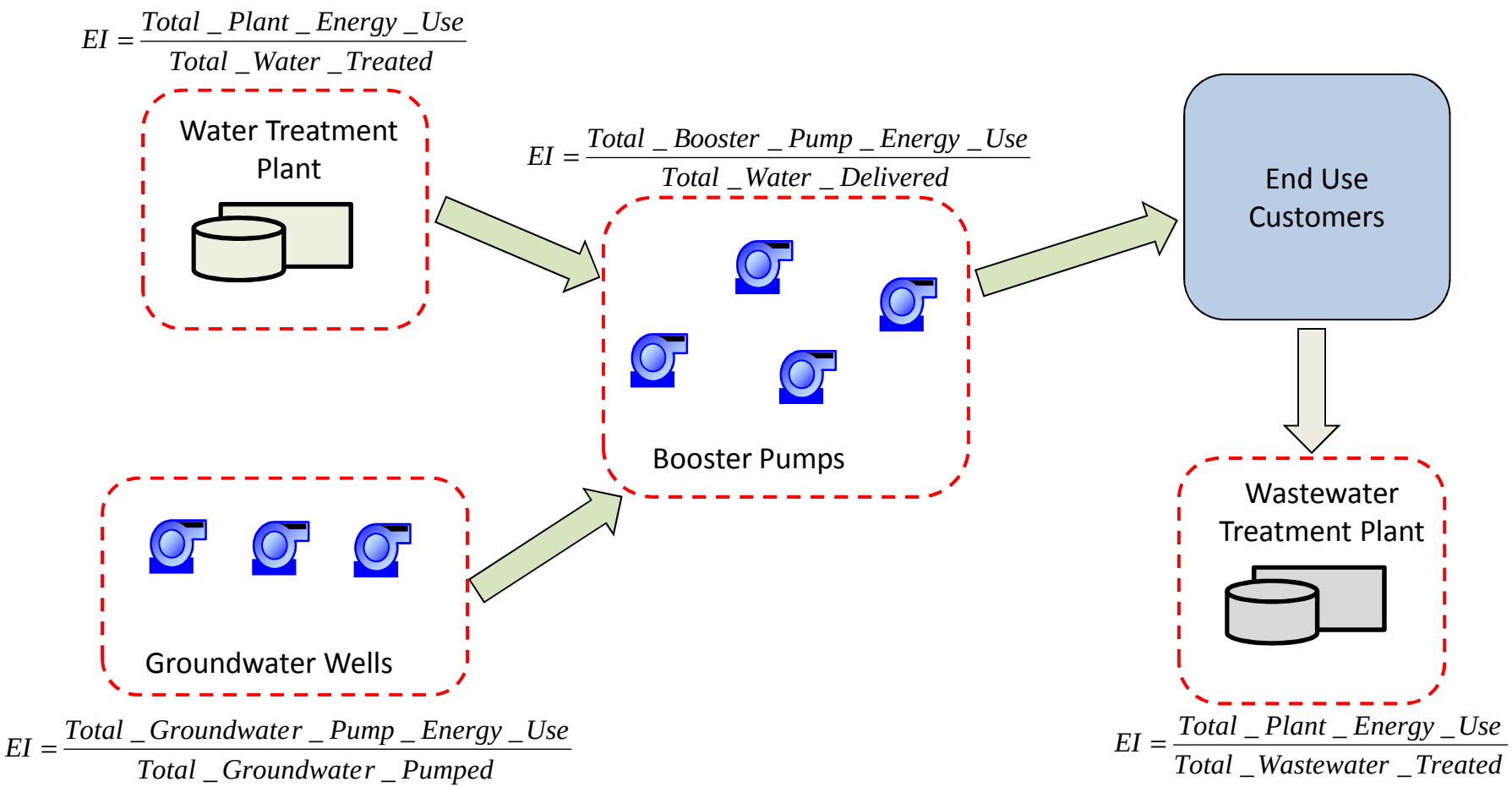
$$EI = \frac{E}{F}$$

- **Aggregating energy and water data from entire agency allows calculation of average Energy Intensity of water delivered by agency.**



$$EI = \frac{Total\_Energy\_Use}{Total\_Water\_Delivered}$$

•Aggregating energy and water data for groups of facilities allows calculation of Energy Intensity by supply type.



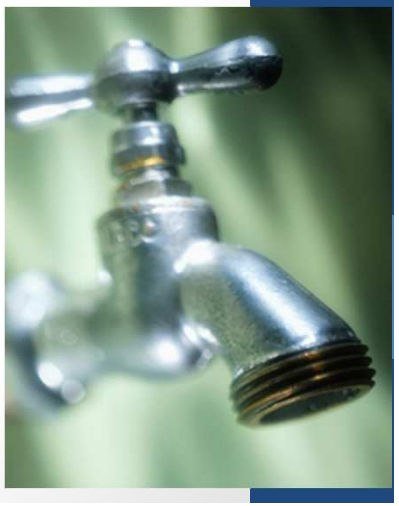
New Activities: Aimed at Embedded Energy Savings

- Commission Guidance Decision (May 2012)
  - IOUs to expand water-energy efficiency programs, determine their cost effectiveness

- leak/loss detection and pressurization studies at water utilities
- Joint water/energy programs for industrial and agricultural customers

Examples of New Water/Energy Pilot Programs

- SoCalEdison: Leak/Loss Audits/Repairs and Pressurization Studies
  - South Bay Cities Council of Governments: Cities of: El Segundo, Lomita, Manhattan Beach, and Inglewood
  - City of Westminster
- San Diego: Commercial Landscape Irrigation Efficiency
  - New technologies: moisture sensors, weather prediction
- SoCalEdison: Continuous Energy Improvement Cohort
  - Public Water Agencies in Orange County



Cost Effectiveness is a Threshold

- If programs cannot be demonstrated to be cost effective to electric and gas IOU ratepayers, than ratepayer funds cannot be used
- Cost effectiveness can ONLY be demonstrated by showing that saving water saves energy
- Therefore, CPUC must estimate embedded energy values for water

Energy Efficiency Savings must be Measured & Verified

- Program implementers are required to demonstrate real savings at the end of a program: for water efficiency this will mean embedded energy savings
- Without energy intensity of supplier, wholesaler and retailer, water savings by customers cannot be translated into energy savings

Water-Energy Efficiency Cost Effectiveness

Commission Guidance (May 2012)

- develop a method for analyzing cost effectiveness of programs/measures that simultaneously save energy & water
  - Need to quantify embedded energy in water to calculate potential energy savings
  - Programs for embedded energy cannot be fully analyzed using existing Cost Effectiveness tools
  - Data not currently collected by other agencies

Next Steps for Water-Energy Cost Effectiveness

1) Stakeholder Process (Ongoing)
   - Project Coordination Group discussion-paper with input on cost effectiveness framework model and feasibility
   - PCG members include IOUs, water agencies, water policy experts
2) Develop Cost Effectiveness Calculations (Fall 2013-Early 2014)
   - Navigant/GEI consulting team chosen to conduct analysis/assist Staff
   - Project Kick-Off mid-November
   - Numerous public workshops throughout 2014
3) Staff Proposes cost effectiveness framework to Commission for consideration and potential adoption (Fall-2014)
4) Framework must include plan for periodic updates of embedded energy calculations

This is where water agency participation may be the breaking point

- If there is no clear method for updating the information relied upon in creating initial cost effectiveness calculations—programs will not continue
- If there is no way to verify savings “upstream” of the customer’s participation in an efficiency program, programs will not continue beyond the “pilot” stage
- This is why we need all water wholesalers to commit to sharing their Energy Intensity value: not doing so may prevent retail agencies & their customers from participating in programs

Your involvement in this process is critical to its success.

Contact Info:

Meredith Younghein

mly@cpuc.ca.gov

(415)703-5953